200300257

No.

THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

The Regents of the University of California

Whereas, THERE HAS BEEN PRESENTED TO THE

Secretary of Agriculture

AN APPLICATION REQUESTING A CERTIFICATE OF PROTECTION FOR AN ALLEGED DISTINCT VARIETY OF SEXUALLY REPRODUCED, OR TUBER PROPAGATED PLANT, THE NAME AND DESCRIPTION OF WHICH ARE CONTAINED IN THE APPLICATION AND EXHIBITS, A COPY OF WHICH IS HEREUNTO ANNEXED AND MADE A PART HEREOF, AND THE VARIOUS REQUIREMENTS OF LAW IN SUCH CASES MADE AND PROVIDED HAVE BEEN COMPLIED WITH, AND THE TITLE THERETO IS, FROM THE RECORDS OF THE PLANT VARIETY PROTECTION OFFICE, IN THE APPLICANT(S) INDICATED IN THE SAID COPY, AND WHEREAS, UPON DUE EXAMINATION MADE, THE SAID APPLICANT(S) IS (ARE) ADJUDGED TO BE ENTITLED TO A CERTIFICATE OF PLANT VARIETY PROTECTION UNDER THE LAW.

NOW, THEREFORE, THIS CERTIFICATE OF PLANT VARIETY PROTECTION IS TO GRANT UNTO THE SAID APPLICANT(S) AND THE SUCCESSORS, HEIRS OR ASSIGNS OF THE SAID APPLICANT(S) FOR THE TERM OF TWENTY YEARS FROM THE DATE OF THIS GRANT, SUBJECT TO THE PAYMENT OF THE REQUIRED FEES AND PERIODIC REPLENISHMENT OF VIABLE BASIC SEED OF THE VARIETY IN A PUBLIC REPOSITORY AS PROVIDED BY LAW, THE RIGHT TO EXCLUDE OTHERS FROM SELLING THE VARIETY, OR OFFERING IT FOR SALE, OR REPRODUCING IT, OR [illegible]ORTING IT, OR EXPORTING IT, OR CONDITIONING IT FOR PROPAGATION, OR STOCKING IT FOR ANY OF THE [illegible] PURPOSES, OR USING IT IN PRODUCING A HYBRID OR DIFFERENT VARIETY THEREFROM, TO THE EXTENT [illegible]D BY THE PLANT VARIETY PROTECTION ACT. IN THE UNITED STATES SEED OF THIS VARIETY (1) [illegible]E SOLD BY VARIETY NAME ONLY AS A CLASS OF CERTIFIED SEED AND (2) SHALL CONFORM TO THE NUM[illegible] GENERATIONS SPECIFIED BY THE OWNER OF THE RIGHTS. (84 STAT. 1542, AS AMENDED, 7 U.S.C. 2321 ET SEQ.)

BEAN, FIELD

'Canario 707'

In Testimony Whereof, *I have hereunto set my hand and caused the seal of the* Plant Variety Protection Office *to be affixed at the City of Washington, D.C. this sixteenth day of May, in the year two thousand and eight.*

Attest:

Commissioner
Plant Variety Protection Office

Secreta[illegible]ulture

REPRODUCE LOCALLY. *Include form number and date on all reproductions* — Form Approved - OMB No. 0581-0055

U.S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL MARKETING SERVICE
SCIENCE AND TECHNOLOGY - PLANT VARIETY PROTECTION OFFICE

APPLICATION FOR PLANT VARIETY PROTECTION CERTIFICATE
(Instructions and information collection burden statement on reverse)

The following statements are made in accordance with the Privacy Act of 1974 (5 U.S.C. 552a) and the Paperwork Reduction Act (PRA) of 1995.

Application is required in order to determine if a plant variety protection certificate is to be issued (7 U.S.C. 2421). Information is held confidential until certificate is issued (7 U.S.C. 2426).

1. NAME OF OWNER: The Regents of the University of California
2. TEMPORARY DESIGNATION OR EXPERIMENTAL NAME: UC Canario 707
3. VARIETY NAME: Canario 707
4. ADDRESS *(Street and No., or R.F.D. No., City, State, and ZIP Code, and Country)*:
University of California
1111 Franklin Street, 12th Floor
Oakland, CA 94607-5200
5. TELEPHONE *(include area code)*: 510 - 587 - 6000
6. FAX *(include area code)*: 510 - 587 - 6090

FOR OFFICIAL USE ONLY
PVPO NUMBER: 2003 00 257
FILING DATE: May 19, 2003

7. IF THE OWNER NAMED IS NOT A "PERSON", GIVE FORM OF ORGANIZATION *(corporation, partnership, association, etc.)*: Corporation
8. IF INCORPORATED, GIVE STATE OF INCORPORATION: CA
9. DATE OF INCORPORATION: June 18, 1868
10. NAME AND ADDRESS OF OWNER REPRESENTATIVE(S) TO SERVE IN THIS APPLICATION. *(First person listed will receive all papers)*
Stephen A. Bent
Foley & Lardner
3000 K Street, N.W., Suite 500
Washington, D.C. 20007-5101

FEES RECEIVED
FILING AND EXAMINATION FEES: $ 3652.00
DATE 5/19/03
CERTIFICATION FEE: $ 768.00
DATE 02/11/2008

11. TELEPHONE *(Include area code)*: 202- 672 - 5404
12. FAX *(Include area code)*: 202 - 672 - 5399
13. E-MAIL: sbent@foleylaw.com
14. CROP KIND *(Common Name)*: Dry Bean
15. GENUS AND SPECIES NAME OF CROP: Phaseolus Vulgaris
16. FAMILY NAME *(Botanical)*: Leguminosae
17. IS THE VARIETY A FIRST GENERATION HYBRID? ☐ YES ☒ NO

18. CHECK APPROPRIATE BOX FOR EACH ATTACHMENT SUBMITTED (Follow instructions on reverse)
a. ☒ Exhibit A. Origin and Breeding History of the Variety
b. ☒ Exhibit B. Statement of Distinctness
c. ☒ Exhibit C. Objective Description of Variety
d. ☒ Exhibit D. Additional Description of the Variety *(Optional)*
e. ☒ Exhibit E. Statement of the Basis of the Owner's Ownership
f. ☒ Voucher Sample *(2,500 viable untreated seeds or, for tuber propagated varieties, verification that tissue culture will be deposited and maintained in an approved public repository)*
g. ☒ Filing and Examination Fee ($3,652), made payable to "Treasurer of the United States" *(Mail to the Plant Variety Protection Office)*

19. DOES THE OWNER SPECIFY THAT SEED OF THIS VARIETY BE SOLD AS A CLASS OF CERTIFIED SEED? *See Section 83(a) of the Plant Variety Protection Act)*
☒ YES *(If "yes", answer items 20 and 21 below)* ☐ NO *(If "no", go to item 22)*

20. DOES THE OWNER SPECIFY THAT SEED OF THIS VARIETY BE LIMITED AS TO NUMBER OF CLASSES? ☒ YES ☐ NO
IF YES, WHICH CLASSES? ☒ FOUNDATION ☐ REGISTERED ☒ CERTIFIED

21. DOES THE OWNER SPECIFY THAT SEED OF THIS VARIETY BE LIMITED AS TO NUMBER OF GENERATIONS? ☐ YES ☐ NO
IF YES, SPECIFY THE NUMBER 1,2,3, etc. FOR EACH CLASS.
☐ FOUNDATION ☐ REGISTERED ☐ CERTIFIED
(If additional explanation is necessary, please use the space indicated on the reverse.)

22. HAS THE VARIETY (INCLUDING ANY HARVESTED MATERIAL) OR A HYBRID PRODUCED FROM THIS VARIETY BEEN SOLD, DISPOSED OF, TRANSFERRED, OR USED IN THE U. S. OR OTHER COUNTRIES?
☐ YES ☒ NO
IF YES, YOU MUST PROVIDE THE DATE OF FIRST SALE, DISPOSITION, TRANSFER, OR USE FOR EACH COUNTRY AND THE CIRCUMSTANCES. *(Please use space indicated on reverse.)*

23. IS THE VARIETY OR ANY COMPONENT OF THE VARIETY PROTECTED BY INTELLECTUAL PROPERTY RIGHT *(PLANT BREEDER'S RIGHT OR PATENT)*?
☐ YES ☒ NO
IF YES, PLEASE GIVE COUNTRY, DATE OF FILING OR ISSUANCE AND ASSIGNED REFERENCE NUMBER. *(Please use space indicated on reverse.)*

24. The owners declare that a viable sample of basic seed of the variety has been furnished with application and will be replenished upon request in accordance with such regulations as may be applicable, or for a tuber propagated variety a tissue culture will be deposited in a public repository and maintained for the duration of the certificate.

The undersigned owner(s) is(are) the owner of this sexually reproduced or tuber propagated plant variety, and believe(s) that the variety is new, distinct, uniform, and stable as required in Section 42, and is entitled to protection under the provisions of Section 42 of the Plant Variety Protection Act.

Owner(s) is(are) informed that false representation herein can jeopardize protection and result in penalties.

SIGNATURE OF OWNER		SIGNATURE OF OWNER	
J Lawrence Fox			
NAME *(Please print or type)* J. Lawrence Fox		NAME *(Please print or type)*	
CAPACITY OR TITLE: Director, Technology Transfer Center University of California, Davis	DATE: 16 May 2003	CAPACITY OR TITLE	DATE

ST-470 (02-10-2003) designed by the Plant Variety Protection Office using Word 2000. Replaces former versions of ST-470, which are obsolete. *(See reverse for instructions and information collection burden statement)*

20030025 7

INSTRUCTIONS

GENERAL: Tobeeffectively filedw iththePl antVariety ProtectionO ffice(PVPO), ALLofthefollowi ngitemsmustbe**receiv ed** inthePVPO:(1)Completed applicationformsignedby theowner;(2)completedexhibitsA,B,C,E;(3)foraseedreproducedvariety atleast2,500viableuntreatedseeds,forahy brid varietyatleast2,500untreatedseedsofeachlinenecessary **toreproduce** thevariety ,orfortuberreproducedvarietiesverificationthataviable*(inthesensethat itwillreproduceanentireplant)*tissueculturew illbedepositedandmaintainedinanapprovedpublic repository;(4)checkdraw nonaU.S.bankfor$3,652($432 filingfeeand$3,220examinationfee),pay ableto"TreasureroftheUnitedStates"*(SeeSection97.6oftheRegulationsandRulesofPractice.)*Partial applicationswillbeheldinthePVPO fornotmorethan90day s, thenreturnedtotheapplicantasunfiled.Mailapplicationa ndotherrequirementstoPlantVariety ProtectionOffice,AMS,USDA,Room401,NALBuilding,10301BaltimoreAvenue,Beltsville,MD 20705-2351.Retainonecopy fory ourfiles.Allitemsonthe faceoftheapplicationareselfexplanatory unlessnotedbelow. Correctionsontheapplicationformandexhibitsmustbeinitialedanddated. **DONOT**use maskingmaterialstomakecorrections.Ifacertificateisa llowed,y ouw illberequestedtosendacheckpay ableto"TreasureroftheUnitedStates"intheamount of$432forissuanceofthecertificate.Certif icatesw illbeissuedtoowner,notlicenseeoragent.

PlantVariety ProtectionOffice
Telephone:(301)504-5518
FAX:(301)504-5291
Homepage: http://www.ams.usda.gov/science/pvpo/pvp.htm

ITEM

18a. Give: (1)thegenealogy ,includingpublicandcommercialvarieties,lines,orclonesused,andthebreedingmethod;
(2)thedetailsofsubsequentstagesofselectionandmultiplication;
(3)evidenceofuniformity andstability ;and
(4)thety peandfrequency ofvariantsduringreproductionandmultiplicationandstatehowthesevariantsmay beidentified

18b. Giveasummary ofthevariety 'sdistinctness.Clearly statehow thisapplicationvariety maybedistinguishedfromallothervarietiesinthesamecrop.Ifthe newvariety ismostsimilartoonevariety oragroupofrelatedvarieties:

(1)identify thesevarietiesandstatealldifferencesobjectively ;
(2)attachstatisticaldataforcharactersexpressednumerically anddemonstratethatthesearecleardifferences;and
(3)submit,ifhelpful,seedandplantspecimensorphotographs(p rints)ofseedandplantcompar isonsw hichclearly indicatedistinctness.

18c. ExhibitCformsareavailablefromthePVPOOfficeformostcrops;specify cropkind.FillinEx hibitC(O bjectiveDescriptionofVariety)formascompletely aspossibletodescribey ourvariety.

18d. Optionaladditionalcharacte risticsand/orphotographs.Describeany additional characteristicsthatcannotbeaccurately convey edinExhibitC.Use comparativevarietiesasisnecessary torevealmoreaccurately thecharacteristicsthataredifficulttodescribe,suchasplanthabit,plantcolor,disease resistance, *etc.*

18e. Section52(5)oftheActrequiresapplicantstofurnishastatementofthebasisoftheapplicant'sownership.AnExhibitEformisavailablefromthePVPO.

19. If"Y es"isspecified *(seedofthisvarietybesoldbyvarietynam eonly,asaclassofcertifiedseed)*,theapplicant**MA YNOT**reversethisaffirmativedecision afterthevariety hasbeensoldandsolabeled,thedecisionpublished,orthecertificateissued.How ever,if"No"hasbeenspecified,theapplicantmay changethechoice. *(SeeRegulationsandRulesofPractice,Section97.103).*

22. *SeeSections41,42,and43oftheActandSection97.5oftheregulationsforeligibilityrequirements.*

23. *SeeSection55oftheActforinstructionsonclaimi ngthebenefitofanearlierfilingdate.*

21.CONTINUED FROMFRONT *(Pleaseprovideastatementastothelimitati onandsequenceofgenerationsthatmaybecertified.)*

22.CONTINUED FROMFRONT *(Pleaseprovidethedateoffirstsale, disposition,transfer,oruseforeachcountryandthecircum stances,ifthevariety (includinganyharvestedmaterial) orahybridproducedfrom thisvarietyhasbeen sold,disposedof,transferred,orusedint heU.S.orothercountries.)*

23.CONTINUEDFROMFRONT *(Pleasegivethecountry,dateoffilingorissuance,andassignedreferencenum ber, ifthevarietyoranycomponentofthe varietyisprotectedbyintellectualproperty right(PlantBreeder'sRightorPatent).)*

NOTES: Itistheresponsibility oftheapplicant/ownertokeepthePVPOinformedofany changesofaddressorchangeofownershiporassignmentorow ner's representativeduringthelifeoftheapplication/certificate. Thereisnochargeforfilingachangeofaddress.Thefeefor filingachangeofow nershipor assignmentorany modificationofowner'snameisspecifiedinSection97.175oftheregulations. *(SeeSection101oftheAct,andSections97.130,97.131, 97.175(h)oftheRegulationsandRulesofPractice.)*

Toav oidconflictw ithotherv arietynamesinuse,theapplicantmustchecktheappropriaterecognizedauthority .Forexample, foragriculturaland vegetablecrops,contact:SeedBranch,A MS,USDA ,Room213, Building306,Beltsv illeA griculturalResearchCenter--East,Beltsv ille,MD20705. Telephone:(301)504-8089.http://www.ams.usda.gov /lsg/seed.htm

2

Exhibit A. (Revised November 8, 2007)
Origin and Breeding History

UC Canario 707 is a selected and purified, true-breeding variety of *Phaseolus vulgaris* dry bean. The original cross generating "CAP 7" (an early-generation source of Canario 707) was performed in 1984, in the Bean Breeding program of Dr. Steve Temple at the Centro Internacional de Agricultura Tropical (CIAT), Palmira, Colombia. The pedigree of the cross was "84 VA-909 x PAD 2." Parental line "84 VA-909" is a CIAT early-generation breeding line and "PAD 2" is an advanced line derived from the cross G6616 x (G4523 X (G4523 X G76)). Names and origins of all "G" lines are available from the CIAT publication "Catalogo de Germoplasma de Frijol Comun" (October, 1992).

In 1992, the F6 family CAP 7 was planted in the University of California Davis (UC Davis) "Observation" nursery at Chico, California. Like most tropically bred CIAT families, CAP 7 proved to be variable for flowering date, podset, grain size and grain shape, grain color, and maturity. Five plants with the best combination of pod set, erect plant architecture, absence of symptoms of Bean Common Mosaic Virus (BCMV), and large yellow grain, were selected and the seeds were bulked. The bulked seeds were used in a 1993 planting, and from 1993-1996 the line was successively mass selected and bulk harvested at Davis, the Kearney Ag Center (Parlier), West Side Research and Extension Center (Five Points), and Chico. The CAP 7 line was repeatedly mass selected for maturity, plant type, grain type, and pod set. During 1993-1996 testing and mass selection, the selected CAP 7 occasionally showed a low frequency of plants infected with BCMV under field conditions.

Following several seasons of mass selection and bulk harvest, thirty plants were selected and individually harvested from the 1996 UC Davis nursery. The necrosis-inducing NL-3 strain of BCMNV was used to test for the presence of the dominant I gene (F. Morales. *Present status of controlling Bean common mosaic virus, in Plant Virus Disease Control* 524 (A. Hadidi, R. K. Khetarpal and H. Koganezawa, eds., 1998)). Twenty-eight families displayed uniform hypersensitive resistance, and two families segregated for the recessive genotype, ii (BCMV-susceptible). The two families segregating susceptible plants were eliminated, and the resistant twenty-eight families were used to produce UC Canario 707. From each family, 8-10 of the best plants were bulk harvested to produce Breeder seed of UC Canario 707.

The resultant selection process has produced a stable and uniform variety. UC Canario 707 was observed to be uniform and stable over six generations. That is, Breeder and Foundation seed of UC Canario 707 has been observed over six generations and shows stable, uniform expression of grain size, grain color, and hypersensitive resistance to Bean Common Mosaic Virus (BCMV). In June 2002, a random sample of 240 seeds from Breeder seed stock were inoculated with the NL-3 strain, to recheck the stability and uniformity of BCMV resistance. One hundred percent of Canario 707 seedlings tested positive for the dominant I resistance gene. No variants have been observed.

Exhibit B (Revised December 27, 2007)

Statement of Distinctness

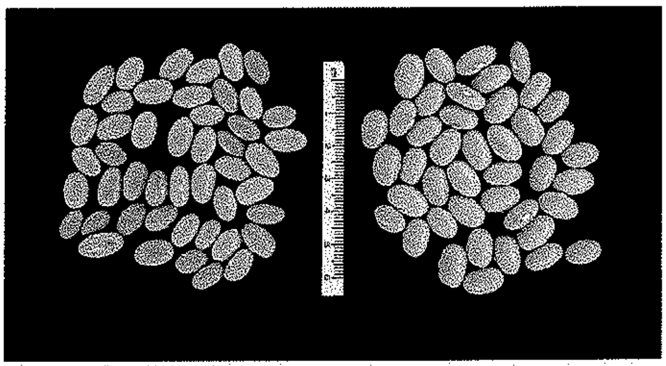
The principal distinguishing features of UC Canario 707 are the combination of a large-seeded, sulfur-yellow grain with I-gene hypersensitive resistance to all identified strains of Bean Common Mosaic Virus (BCMV). Canario 707 grain, examined 2-5 months after harvest, most closely matches hue 7.5Y from the Munsell matte collection (**MUNSELL BOOK OF COLOR**). Within hue 7.5Y, individual seeds most frequently match chips 7.5Y 8/4, 7.5Y 8/6, 7.5Y 8.5/2, 7.5Y 8.5/4, and 7.5Y 8.5/6.

In plant growth habit and grain type, Canario 707 most closely resembles the Mexican cultivar "Mayocoba" (CIAT germplasm accession G 13094) and several yellow-seeded Mexican introductions referred to generically as "Peruanos" (herein referred to as Azufrado Peruano 87). While Canario 707 has resistance to BCMV, conferred by the I gene, Peruano and Mayocoba carry the i allele, conferring susceptibility to some or all strains of BCMV. Further distinguished from Peruano and Mayocoba, Canario 707 displays a hypersensitive response to necrosis-inducing strains of the closely related Bean Common Mosaic Necrosis Virus (BCMNV). F. Morales. *Present status of controlling Bean common mosaic virus, in Plant Virus Disease Control* 524 (A. Hadidi, R. K. Khetarpal and H. Koganezawa, eds., 1998). Over the six subsequent generations that Canario 707 has been multiplied, resistance to BCMV is stable, uniform, and heritable.

In a comparison with Mayocoba G 13094, Canario 707 seeds have a larger size, greater uniformity, and deeper yellow color. See Figure 1.

While Canario 707 resembles yellow-seeded varieties, Mayocoba, Peruanos, and Canario 707 varieties can be differentiated by DNA fingerprinting. As indicated in as-filed Exhibit D, Amplified Fragment Length Polymorphism (AFLP) markers were used to fingerprint yellow bean cultivars for determining the genetic relationships between yellow bean and other bean germplasm. AFLP analysis was performed as described by P. Vos *et al.*, *Nucleic Acids Research* 23: 4407 (1995), and modified by Barcaccia *et al.*, *Plant Breed* 118: 335 (1999). The primer combinations included five *Eco*RI-*Mse*I (with selective bases CAC/AAG, CAC/AGC, CCA/AGA, CCA/AGC, and CAA/AAG) and five *Pst*I-*Mse*I combinations (AG/CAC, AG/CAT, AG/CCA, AT/CAA, and AT/CAC). The 10 AFLP primer combinations revealed 133 polymorphic amplified fragments in sampled Andean and Mesoamerican accessions.

Mayocoba (G13094) Canario 707



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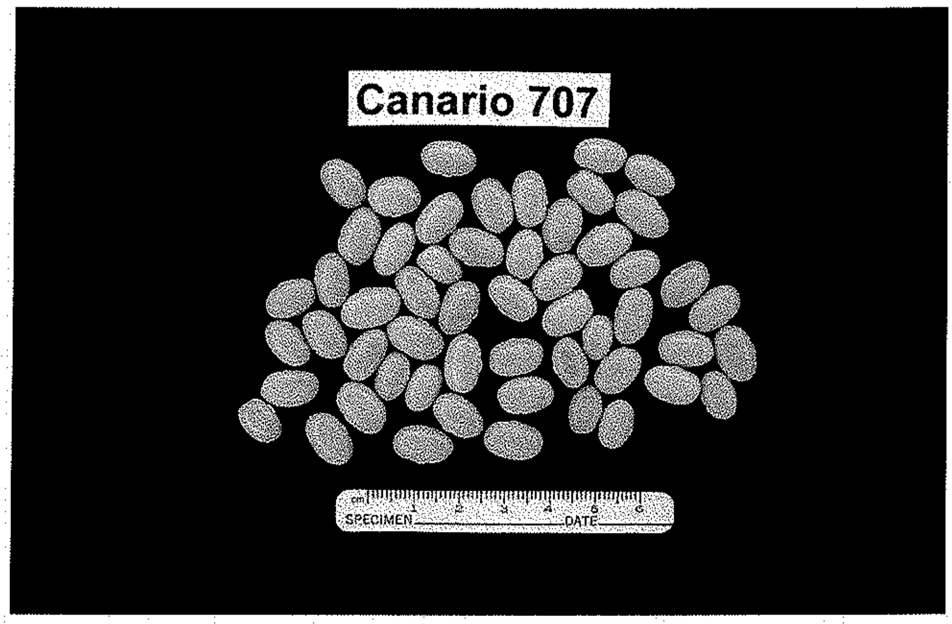

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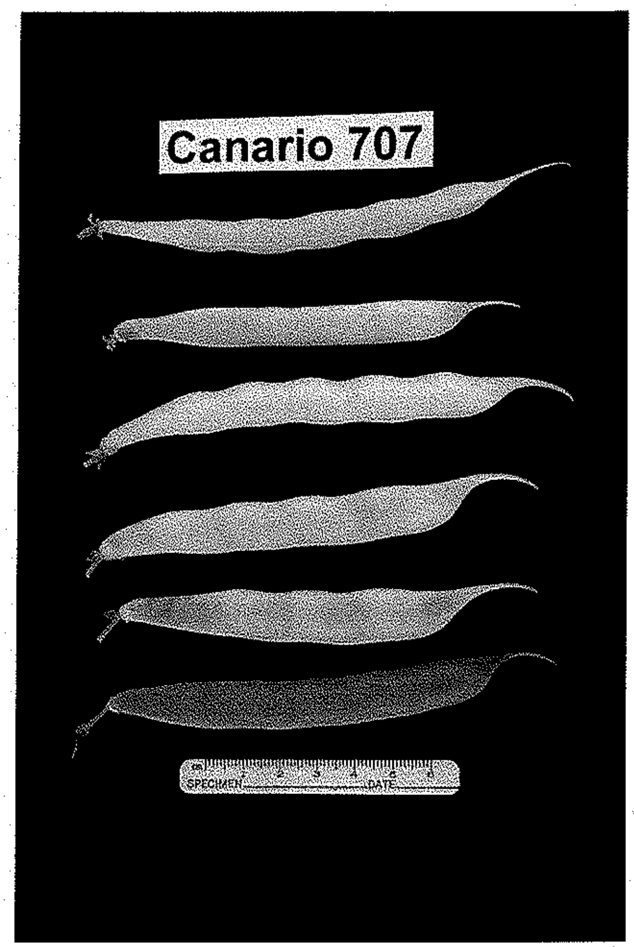

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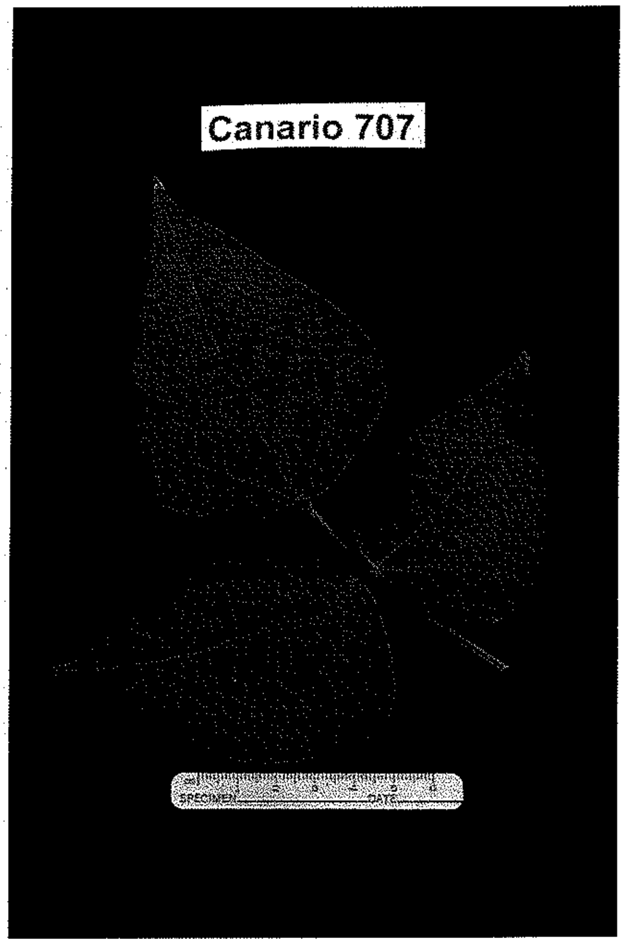
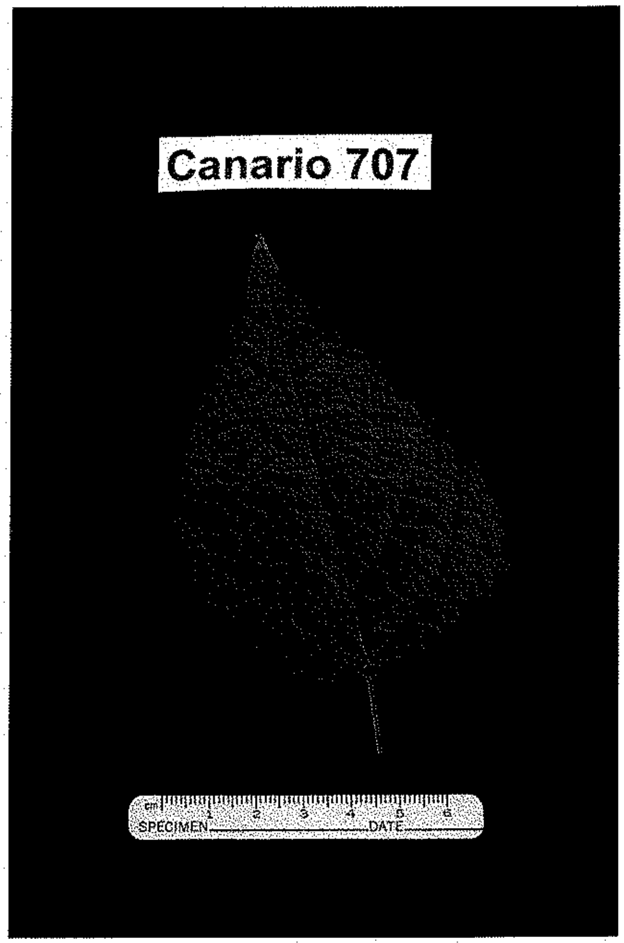

Canario 707


Canario 707
cm 1 2 3 4 5 6
SPECIMEN DATE

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U.S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL MARKETING SERVICE
SCIENCE AND TECHNOLOGY
PLANT VARIETY PROTECTION OFFICE
BELTSVILLE, MD 20705

Exhibit C

OBJECTIVE DESCRIPTION OF VARIETY
Field Bean (*Phaseolus vulgaris* L.)

NAME OF APPLICANT (S)	TEMPORARY OR EXPERIMENTAL DESIGNATION	VARIETY NAME
Steve Temple	Canario 707	Dry Bean
ADDRESS (Street and No. or RD No., City, State, Zip Code, and Country) Plant Sciences Dept, Mail Stop One Univ. California Davis, CA, 95616		PVPO NUMBER Application No. 200300257

PLEASE READ ALL INSTRUCTIONS CAREFULLY:

Provide data for all characters unless indicated as "optional". Place numbers in the boxes for the characters or numerical values that best describe this variety. Measured data should be the mean of an appropriate number of well spaced (15-20 cm) plants. The Royal Horticultural Society or any recognized color standard may be used to determine plant color. Designate the color system used below.

COLOR SYSTEM USED:

LOCATION OF THE TEST(S) TO EVALUATE THIS VARIETY: Davis, CA

1. MARKET CLASS:

[1 2]

CLASS	CHECK
1 = Navy (Pea)	Seafarer
2 = Small White	Aurora
3 = Black	Midnight
4 = Pinto	UI-114
5 = Great Northern	UI-59
6 = Small Red	NW-59
7 = Pink	Viva
8 = Cranberry	UI-50
9 = Dark Red Kidney	Montcalm
10 = Light Red Kidney	Redkloud
11 = Yellow Eye	Steuben
12 = Other (Specify Sulphur Yellow)	

2 = MATURITY:

[3] 1 = Early (80-90 days) 2 = Medium (90-100 Days) 3 = Late (> 100 Days)

[1 0 5] Days from Planting to Harvest Maturity

[- - - -] Heat Units from Planting to Harvest Maturity (Optional). Specify Base Temperature Used: ____

[9 5] Days from Planting to Harvest Maturity of Check Variety (Use Check Appropriate to Market Class Shown in Item 1)

Note: Calif. beans cut 2 weeks before "maturity"

3. PLANT HABIT:

[1]

TYPE

1 = Ia Bush-determinate, Strong and Erect Stem and Branches
2 = Ib Bush-determinate, Weak Stem and Branches
3 = IIa Erect Growth Habit-Indeterminate, Guides (Runners) short or not developed
4 = IIb Erect Growth Habit-Indeterminate, Guides Medium to Long, with no Ability to Climb
5 = IIIa Vine-indeterminate, Short Guides with no ability to Climb
6 = IIIb Vine-indeterminate, Long Guides with Ability to Climb
7 = IVa Indeterminate Climbing, Pods Distributed Throughout the Plant
8 = IVb Indeterminate Climbing, Pods Concentrated on the Upper Part of the Plant

[5 8] Average Height of Mature Plant, in cm.

[5 4] Average Height of Check Variety, in cm. (Use Same Check as Above)

[3] Pod Position: 1 = Low (Lower Pods Touching Soil Surface) 2 = High (Lower Pods not Touching Soil Surface) 3 = Scattered (Not Concentrated High or Low)

[2] Adaptability to Machine Harvest: 1 = Adapted 2 = Not Adapted

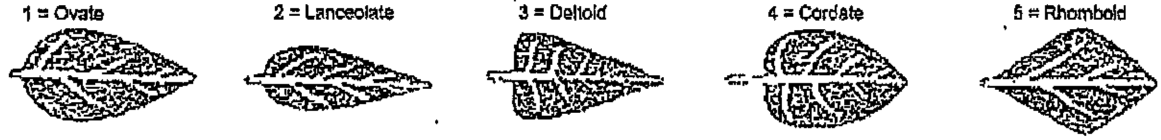
[2] Lodging Resistance: 1 = Good 2 = Fair 3 = Poor

10

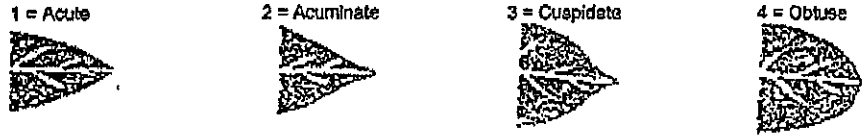
4. LEAFLET MORPHOLOGY: (Use terminal Leaflet of a Fully Expanded Trifoliolate)

[2] 1 = Smooth 2 = Wrinkled [1] 1 = Dull 2 = Glossy 3 = Semiglossy 4 = Variable

Shape: [1] 1 = Ovate 2 = Lanceolate 3 = Deltoid 4 = Cordate 5 = Rhomboid



Apex of Leaflet: [2] 1 = Acute 2 = Acuminate 3 = Cuspidate 4 = Obtuse



Base of Leaflet: [1] 1 = Obtuse 2 = Oblique 3 = Cordate 4 = Cuneate 5 = Attenuate

5. FLOWER COLOR AND DAYS TO BLOOM:

[3] Color of Standard: Soft 1 = White 2 = Cream 3 = Pink 4 = Blue 5 = Purple

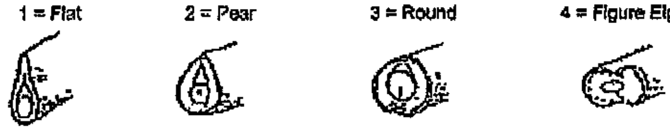
[3] Color of Keel: Soft 1 = White 2 = Cream 3 = Pink 4 = Blue 5 = Purple

[3] Color of Wings: Soft 1 = White 2 = Cream 3 = Pink 4 = Blue 5 = Purple

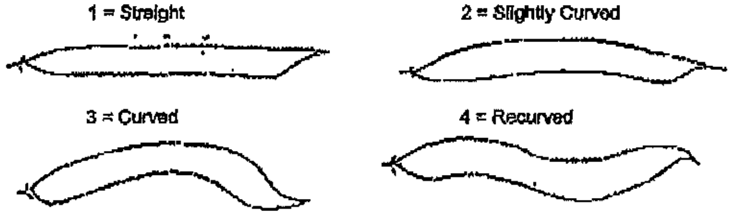
[4][2] Days to 50% Bloom

6. POD MORPHOLOGY: (Green Pod Morphology Optional)

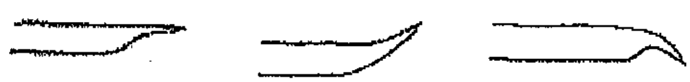
Green	Mature		
1	1	Color Pattern:	1 = Solid 2 = Striped 3 = Blotched 4 = Mottled 5 = Other ______
3	5	Primary Color:	1 = Purple 2 = Red 3 = Green 4 = Yellow 5 = Tan 6 = Brown 7 = Other ______
–	–	Color Modifier:	1 = Light 2 = Light Medium 3 = Medium 4 = Medium Dark 5 = Dark
–	–	Secondary Color:	1 = Purple 2 = Red 3 = Green 4 = Yellow 5 = Tan 6 = Brown 7 = Other ______
2	3	Cross Section Shape:	1 = Flat 2 = Pear 3 = Round 4 = Figure Eight



[1] [2] Pod Curvature 1 = Straight 2 = Slightly Curved 3 = Curved 4 = Recurved



[3] [3] Pod Beak Orientation: 1 = Straight 2 = Curved Upward 3 = Curved Downward 4 = Variable
Average Beak Length, in cm. ______



[2] [2] Constrictions: 1 = None 2 = Slight 3 = Deep

[5].[ ] Average Number of Seeds per Pod

11

7. SEED COLOR:

[1] 1 = Shiny 2 = Dull 3 = Semi-shiny 4 = Variable

[1] 1 = Monochrome 2 = Polychrome

[2] Primary Color: 1 = White 2 = Yellow 3 = Buff 4 = Tan 5 = Brown 6 = Pink 7 = Red 8 = Purple 9 = Blue 10 = Black 11 = Other ______

[3] Secondary Color: 1 = White 2 = Yellow 3 = Buff 4 = Tan 5 = Brown 6 = Pink 7 = Red 8 = Purple 9 = Blue 10 = Black 11 = Other ______

[1] Color Pattern: 1 = Solid 2 = Splashed 3 = Mottled 4 = Striped 5 = Flecked 6 = Dotted

[2] Hilar Ring: 1 = Absent 2 = Present

[3]* Hilar Ring Color: 1 = White 2 = Yellow 3 = Buff 4 = Tan 5 = Brown 6 = Pink 7 = Red 8 = Purple 9 = Blue 10 = Black 11 = Other ______ * Please See Attached Sheet...

8. SEED SHAPE AND WEIGHT:

[3] Shape of Seed Taken From Middle of Pod: 1 = Round 2 = Oval 3 = Cuboid 4 = Kidney 5 = Truncate Fastigate

[40] Dry Seed Weight in g/100g Seeds (Adjusted to 12% Moisture) (Mayocoba = 34.6 g/100 seeds)

9. ANTHOCYANIN PIGMENTATION:

1 = Absent
2 = Present

[1] Flowers [1] Stems [1] Pods [1] Seeds

[1] Leaves [1] Petioles [1] Peduncles [1] Nodes

10. KNOWN DISEASE REACTION:

DISEASES – COMMON NAME: Anthracnose, Rust, Powdery Mildew, Fusarium Root Rot, Pythium Root Rot, Rhizoctonia Root Rot, Pythium Wilt, Sclerotinia White Mold, angular Leaf Spot, Bacterial Wilt, Halo Blight, Fuscous Blight, Common Bacterial Blight, Red Node Virus, Pod Mottle Virus, Bean Common Mosaic Virus, Bean Yellow Mosaic Virus, Curly Top Virus, Bacterial Brown Spot, Bean Southern Mosaic Virus, Other (Specify) ______

Reaction: 1 = Susceptible 2 = Resistant 3 = Tolerant 4 = Avoidance 5 = Hypersensitive

(Give the Common Name (CN), Scientific Name (SN), and Race(s), Where Applicable)

[2] Disease: CN Bean Common Mosaic Virus; SN SAME; Race(s) All Strains;

[5] Disease: CN Bean Common Mosaic Necrosis Virus; SN SAME; Race(s) All Strains;

[ ] Disease: CN ______; SN ______; Race(s) ______;

[ ] Disease: CN ______; SN ______; Race(s) ______;

[ ] Disease: CN ______; SN ______; Race(s) ______;

[ ] Disease: CN ______; SN ______; Race(s) ______;

11. KNOWN INSECT/NEMATODE RESISTANCE:

PESTS – COMMON NAME: Aphids, Bean Pod Weevil, Bruchid Beetle, Corn Earworm, Flea Beetle, Leaf Hopper, Lesion Nematode, Lygus, Mexican Bean Beetle, Root Know Nematode, Corn Seed Maggot, Spider Mites, Thrips, Weevils, Western Bean Cutworm, Other (Specify) ______

Reaction: 1 = Susceptible 2 = Resistant 3 = Tolerant 4 = Avoidance

(Give the Common Name (CN), Scientific Name (SN), and Race(s), Where Applicable)

[1] Pest: CN Spider Mites; SN ______; Race(s) ______;

[ ] Pest: CN ______; SN ______; Race(s) ______;

[ ] Pest: CN ______; SN ______; Race(s) ______;

12. KNOWN PHYSIOLOGICAL STRESS REACTION:

1 = Susceptible 2 = Resistant
3 = Tolerant 4 = Avoidance

[1] Heat [ ] Cold [1] Drought [ ] Air Pollution

12

Applicant: Steve TEMPLE
UC Canario 707

Exhibit D

Evidence in Support of Variety Distinctness Through DNA Analysis

Amplified fragment length polymorphism (AFLP) markers were used to fingerprint yellow bean cultivars for determining the genetic relationships between yellow bean and other bean germplasm. AFLP analysis was performed as described by P. Vos et al. *Nucleic Acids Research* 23:4407 (1995), and modified by Barcaccia et al. *Plant Breed* 118:335 (1999). The primer combinations included five *Eco*RI-*Mse*I (with selective bases CAC/AAG, CAC/AGC, CCA/AGA, CCA/AGC, and CAA/AAG) and five *Pst*I-*Mse*I combinations (AG/CAC, AG/CAT, AG/CCA, AT/CAA, and AT/CAC). The 10 AFLP primer combinations revealed 133 polymorphic amplified fragments in sampled Andean and Mesoamerican accessions.

AFLP analysis revealed that Canario 707 is found within the original Andean gene pool, whereas the cultivar "Enola" is of Peruano-descent. Canario 707 differs from Enola for 15 of 133 amplified DNA fragments, revealed by specific primers Ecac/Maag (2), Ecca/Maga (1), Ecaa/Maag (1), Pag/cac (2), Pag/Mcat (5), and Pag/Mcca (4).

81
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14

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The Dark Corona Character in Seedcoats of Common Bean Cosegregates with the Pink Flower Allele v^{lae}

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Additional index words. *Phaseolus vulgaris*, inheritance, genetic linkage

Abstract. **Crosses were made with two common bean (*Phaseolus vulgaris* L.) parents that have pink flowers (v^{lae}/–) and mineral-brown seedcoats with dark corona, viz., v^{lae} BC$_3$ 5–593 (derived from Lamprecht V0491) and F$_3$ v^{lae} dark corona (derived from Lamprecht M0048). The third parent v BC$_2$ 5–593 had white flowers (v/v) and mineral-brown seedcoats without dark corona (derived from Lamprecht M0056). The F$_2$ progenies of the crosses v BC$_2$ 5–593 x v^{lae} BC$_3$ 5–593 and F$_3$ v^{lae} dark corona x v BC$_2$ 5–593 segregated for only two phenotypic classes: either pink flowers and seeds with dark corona or white flowers and seeds without dark corona. Thus, it was demonstrated that the dark corona character (*Cor*) is either tightly linked to v^{lae} (<4 map units) or is a pleiotropic effect of v^{lae}. Pleiotropy is more probable, but tight linkage cannot be ruled out. A linkage of 15 map units between *Cor* and *R* (currently, *R* is known to be tightly linked with *C*) reported by Lamprecht was not found by subsequent authors, and the linkage map of common bean should be revised accordingly, i.e., no linkage exists between *V* (*Cor*) and *C*.**

In 1985 a program was initiated at the Univ. of Florida to develop genetic stocks with selected marker genes of common bean (*Phaseolus vulgaris*) in a common genetic background by backcrossing to a recurrent parent. The recurrent parent was a Florida dry bean breeding line, 5–593, that had been developed before 1985. One of the recessive marker characters that was backcrossed into 5–593 was the pink (laelia) flower trait controlled by the v^{lae} allele, where the dominant allele V produces bishops violet (purple) flowers and the fully recessive allele v produces pure white flowers (Lamprecht, 1935; Prakken, 1970). The genetic stock carrying the pink flower allele v^{lae} was discovered to have a dark (black) corona around the hilum scar of the seeds, which had a mineral-brown color over the remainder of the seedcoat. The dark corona character was reported by Lamprecht (1934) to be controlled by the *Cor* locus. This paper describes the results of an investigation to test the hypothesis that the v^{lae} allele has an unreported pleiotropic effect on seedcoat color pattern, viz., production of a dark corona.

Materials and Methods

Florida dry bean breeding line 5–593 has determinate habit, purple flowers, and shiny, pure black seedcoats. The seedcoat genotype of 5–593 is $T\ P\ [C\ r]\ D\ J\ G\ B\ V\ Rk$ (Bassett, 1994; Prakken, 1970, 1972).

Following the usual recurrent backcross procedure for developing the genetic stocks referred to above, there was strong selection in the F$_2$ generation of each successive backcross for the phenotype of the recurrent parent. The goal was to create a genetic stock that fully recovered the appearance of 5–593 except for the selected marker trait, i.e., there was strong selection against all other marker traits. When the allele v was substituted into the genetic background of 5–593, giving $P\ C\ D\ J\ G\ B\ v$, it had two pleiotropic effects, viz., changing purple flowers to pure white and changing pure black seedcoats to mineral brown (Prakken, 1970). The source of the v allele was Lamprecht Line M0056 (now PI 527830), which is known to carry v (Bassett et al., 1990). The resulting stock was designated v BC$_2$ 5–593, indicating two backcrosses to 5–593 with strong selection for the recurrent parent phenotype. The genetic stock v^{lae} BC$_3$ 5–593 was created in a similar manner, using Lamprecht Line V0491 (now PI 527745) as the source of the v^{lae} allele. When the v^{lae} allele was substituted into the genetic background of 5–593, giving $P\ C\ D\ J\ G\ B\ v^{lae}$, it had two well-established pleiotropic effects, viz., changing purple flowers to pink and changing pure black seedcoat color to mineral brown (Prakken, 1970). The resulting stock was designated v^{lae} BC$_3$ 5–593, indicating three backcrosses to 5–593 with strong selection for the recurrent parent phenotype. However, v^{lae} BC$_3$ 5–593 had an additional trait not reported in previous literature, viz., a dark (black) corona. The corona phenotypes of v^{lae} BC$_3$ 5–593 (dark corona) and v BC$_2$ 5–593 (no dark corona) are illustrated in a drawing of the seedcoat patterns on the ventral side of the seeds (Fig. 1). The corona phenotype of v BC$_2$ 5–593 was slightly darker brown than the surrounding mineral-brown seedcoat and was described as having no dark corona (Fig. 1). For additional illustration and discussion of the corona character a good current reference was provided by Leakey (1988).

An additional source of pink flowers and the v^{lae} allele was used in the investigation, viz., Lamprecht Line M0048 (now PI 527829). The letter M signifies multigaris in Lamprecht's terminology, i.e., a line that is derived from the interspecific cross *P. vulgaris* x *P. coccineus* (formerly *multiflorus*). Line M0048 has dark seal brown seedcoat color and determinate habit. The dark seal brown color is hypothesized to be the expression of the genotype $P\ [c\ R]\ J\ G\ B\ v^{lae}$ (M.J. Bassett, unpublished data). The cross M0048 x 5–593 was used to substitute the $[C\ r]$ allele of 5–593 for the $[c\ R]$ allele of M0048. Thus, an F$_3$ progeny was obtained that was true breeding for pink flowers and mineral-brown seedcoats with dark corona ($P\ [C\ r]\ J\ G\ B\ v^{lae}$). The line is designated F$_3$ v^{lae} dark corona.

Two crosses were made to test the hypothesis that the dark corona character is not controlled by a gene Cor that is independent of V, but is a pleiotropic effect of v^{lae}. The first was v BC$_2$ 5–593 x v^{lae} BC$_3$ 5–593, and the second was F$_3$ v^{lae} dark corona (seven F$_3$ plants used) x v BC$_2$ 5–593. The F$_2$ plants from the first cross were grown in the field in Spring 1993 and the F$_2$ from the second cross were grown in the field in Spring 1992. Data were taken on the flower and seedcoat color of F$_1$ and F$_2$ progeny. A single seed was harvested from each plant, keeping the seeds from the two flower

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[1]Professor.

15

color classes separate. The seeds were later examined for any indication of segregation for phenotypic classes.

I wrote letters to the curators of several common bean germplasm collections in Europe requesting seed of the two parental lines used by Lamprecht (1934) in the experiments leading to the discovery of *Cor*, viz., 'de la Chine' (Lamprecht Line 29) and 'Pariser Gelbe' (Lamprecht Line 23). Neither of the parental lines used by Lamprecht (1934) are extant in the U.S.Department of Agriculture plant introduction collection (at Pullman, Wash.) of Lamprecht's experimental materials, PI 527711 through PI 527878 (168 accessions). I was unsuccessful in obtaining seed of 'de la Chine', but I obtained 'Pariser Gelbe' (BGRC #25351) from the Institut für Pflanzenbau der Bundesforschungsanstalt für Landwirtschaft (FAL), Bundesallee 50, D–38116 Braunschweig, Germany. The seedcoat and corona colors of 'Pariser Gelbe' (#25351) are identical to the description of Lamprecht (1934), and the seed shape is also the same as his illustration. Seed of 'Pariser Gelbe' (#25351) was grown in the greenhouse at Gainesville and data were taken on the flower color.

Results and Discussion

The F_1 plants from the cross v BC_2 5–593 x v^{lae} BC_3 5–593 had pink flowers (v^{lae}/v) and mineral-brown seeds with dark corona (data not shown). The F_2 segregated for only two phenotypic classes rather than the four classes that would be expected if flower color and dark corona segregated independently (Table 1). Plants with pink flower color always had dark (black) corona, and plants with white flowers always had no dark corona. Thus, there must be either tight linkage between the genes controlling the two characters or pleiotropic effects originating from the v^{lae} allele.

There was full dominance for the dark corona trait, whereas Lamprecht (1934) reported partial dominance for dark corona. However, it should be noted that the parental materials of Lamprecht had seedcoat genotypes that were different from the parents in Table 1. For example, Lamprecht Line 23, 'Pariser Gelbe,' had genotype *P C j g b v* with corona, and Line 29, 'de la Chine,' had genotype *P C j g b v* without corona. It is probable that 'Pariser Gelbe' carried v^{lae}, but Lamprecht (1934) did not give information on the flower color and probably omitted the superscript lae as an irrelevant distraction. This view is supported by the observation that 'Pariser Gelbe' (#25351) had pink flowers, which is characteristic of plants with v^{lae}.

The dark corona in v^{lae} BC_3 5–593 was black, whereas the corona in 'Pariser Gelbe' was a light purple color. It is my hypothesis that the action of the recessive alleles at *G* and *B* greatly reduced the quantity of anthocyannin pigment present (M.J. Bassett, unpublished data; Prakken, 1970). Therefore, the reduction in pigment produced by the heterozygote *Cor/cor* (really v^{lae}/v) gave a much paler purple corona (Lamprecht, 1934). The genotype cor/cor (really v/v) had no corona (Lamprecht, 1934). The parental lines derived from 5–593 had dominant alleles at *G* and *B* and, therefore, had a much higher concentration of anthocyanin (Table 1). Thus, the heterozygote v^{lae}/v did not produce a discernible reduction in pigment, but it is probable that a reduction actually took place that is proportional to the one observed by Lamprecht (1934). It is my hypothesis that the absolute concentration of pigment must be reduced to some critical threshold level for the loss to be discernible to the naked eye. Clearly, the partial dominance of *Cor* (v^{lae}) for corona expression depends on the background genotype for visual evaluation of its expression.

The F_1 plants from the cross F_3 v^{lae} dark corona x v BC_2 5–593 had pink flowers and mineral-brown seed with dark corona (data not shown). In the F_2 progeny, only two phenotypic classes were observed, viz., plants with pink flowers and seeds with dark corona on mineral brown or plants with white flowers and seeds with no darl corona on mineral brown (Table 1). As with the previous cross, there was no independent segregation of flower color and corona color. One must conclude that either the genes are linked or the two characters are pleiotropic effects of a single locus, *V*. Considering the data from both crosses (Table 1), the possible linkage would be less than four map units, as estimated by adding a single (hypothetical) crossover event to the observed data and using the maximum likelihood equations of Allard (1956). One way to symbolically represent such tight linkage is to use the bracket convention, where two or more tightly linked genes are written with their gene symbols enclosed in brackets (Bassett, 1991). For the materials used in the above experiments, the

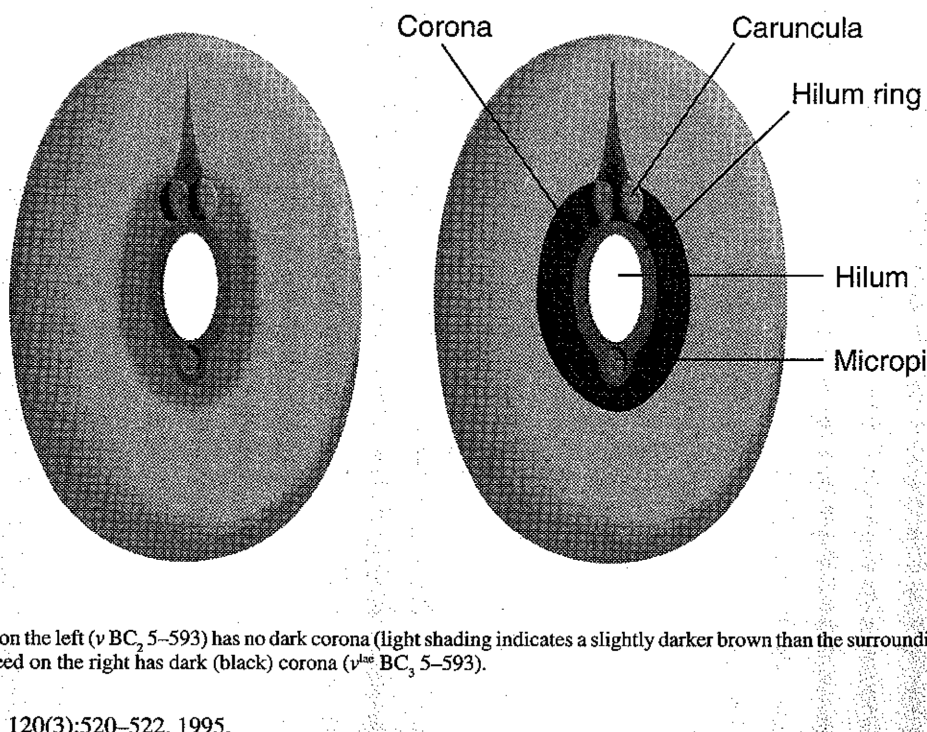

Fig. 1. The seed on the left (v BC_2 5–593) has no dark corona (light shading indicates a slightly darker brown than the surrounding mineral brown), whereas the seed on the right has dark (black) corona (v^{lae} BC_3 5–593).

16

Table 1. Segregation for flower and seed coat color in the F_2 from the crosses v BC_2 5–593 x v^{lae} BC_3 5–593, and F_3 v^{lae} dark corona x v BC_2 5–593.

Cross no.	Pink flowers, mineral-brown seeds with dark corona[z] (v^{lae}/–)	White flowers, mineral-brown seeds with no dark corona[y] (v/v)	χ^2 3:1	P value
1	269	107	2.397	0.12
2	1247	650	86.84	<0.001

[z]The dark corona is black in those genotypes because of dominant *B*. In other genetic backgrounds, v^{lae} produces various shades of purple in the corona, e.g., with recessive *b* or *g b*.
[y]The corona is slightly darker brown than the surrounding mineral brown of the remainder of the seedcoat.

symbols would be [v^{lae} *Cor*] for plants with pink flowers and dark corona and [*v cor*] for plants with white flowers and no corona (Table 1).

The segregation for pink and white flowers in the F_2 from the cross F_3 v^{lae} dark corona x v BC_2 5–593 was highly disturbed in relation to the expected 3:1 ratio for pink to white, respectively (Table 1). That result is not surprising, considering that the F_3 v^{lae} dark corona parent was derived from M0048. The initial cross M0048 x 5–593 also had a highly disturbed 3:1 F_2 segregation at the *V* locus for purple to pink flowers, respectively (data not shown). Disturbed segregation ratios in the progenies from interspecific crosses involving *P. vulgaris* and *P. coccineus* are common and have been frequently reported (as reviewed by Smartt, 1970).

Lamprecht (1961) reported a linkage of 15 map units between *Cor* and *R* and incorporated that linkage into his linkage group I. The current view is that *R* is tightly linked in the complex *C* locus (Bassett, 1991; Prakken, 1974). If *Cor* is tightly linked to v^{lae} as demonstrated by the data (Table 1), then the linkage of Lamprecht (1961) translates into a linkage of 15 map units between *V* and *C*. No such linkage was found in the extensive work by Nakayama (1960, 1964, 1965, 1968) and Prakken (1972) with materials segregating jointly at *V* and *C*. Linkage group I should be revised accordingly, viz., splitting linkage group I into two separate linkages: *D* with *V* and *C* with tri. The *D* locus controls hilum ring color, *C* controls seedcoat color, and *tri* controls tricotyledony (Bassett, 1991).

The data presented above are sufficient to demonstrate tight linkage between dark corona color and pink flower color, but other observations suggest that the better hypothesis is that dark corona is a pleiotropic effect of v^{lae}. I have observed many seedcoat genotypes in the course of my career and have never observed either of the putative crossover phenotypes, e.g. (*v Cor*) with pure white flowers and mineral-brown seeds with dark corona due to the genotype *T P C J G B v*, or (v^{lae} cor) with pink flowers and mineral-brown seedcoats with no dark corona due to the genotye *T P C J G B* v^{lae}. Until such recombinants have been found and verified, the more probable hypothesis is pleiotropy.

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17

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18